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Our discrete math class has now been given the awesome responsibility of deciding which song is the favorite or the "best". After you carefully listen to each song, please list them in the order of your preference, 1 being highest and 5 being lowest.

\_\_\_\_\_ I Gotta Feeling (The Black Eyed Peas)  
\_\_\_\_\_ Best I Ever Had (Drake)  
\_\_\_\_\_ Knock You Down (Keri Hilson)  
\_\_\_\_\_ Use Somebody (Kings of Leon)  
\_\_\_\_\_ You Belong With Me (Taylor Swift)

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1.2 Group Ranking Methods

Example 1

Students were asked to rank their classes on a preferential ballot. The following are the results:

Class / # of Students	38	30	25	7
English	1 <sup>st</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	4 <sup>th</sup>
History	2 <sup>nd</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>
Science	4 <sup>th</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
Math	3 <sup>rd</sup>	4 <sup>th</sup>	1 <sup>st</sup>	2 <sup>nd</sup>

Organize the information into a preference schedule.

Which is the favorite class?

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

### Example 2

People were asked to rank pizza on a preferential ballot. The following are the results:

<b>Pizza / # of People</b>	<b>8</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>Ham</b>	2 <sup>nd</sup>	1 <sup>st</sup>	2 <sup>nd</sup>	2 <sup>nd</sup>
<b>Pepperoni</b>	1 <sup>st</sup>	4 <sup>th</sup>	4 <sup>th</sup>	4 <sup>th</sup>
<b>Sausage</b>	4 <sup>th</sup>	3 <sup>rd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>
<b>Veggie</b>	3 <sup>rd</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	3 <sup>rd</sup>

Organize the information into a preference schedule.

Plurality Winner:

Majority Winner:

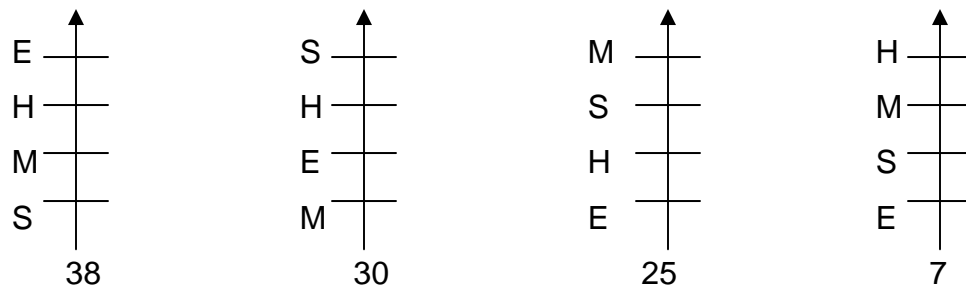
Borda Count method:

Runoff method:

Sequential Runoff method:

### 1.3 More Group Ranking Methods

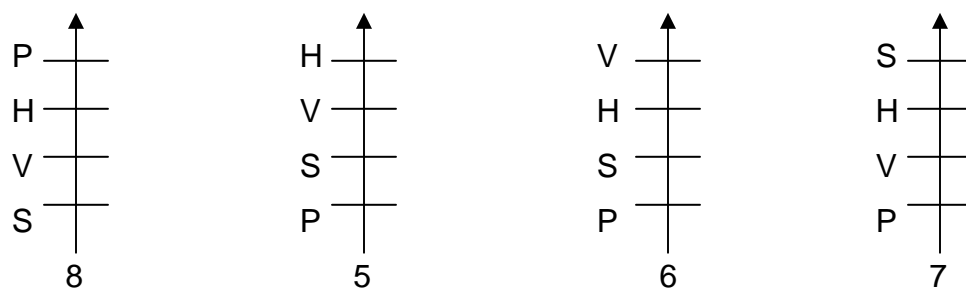
#### Example 1



Sequential Pairwise method:

Condorcet method:

#### Example 2



Sequential Pairwise method:

Condorcet method:

### Example 3

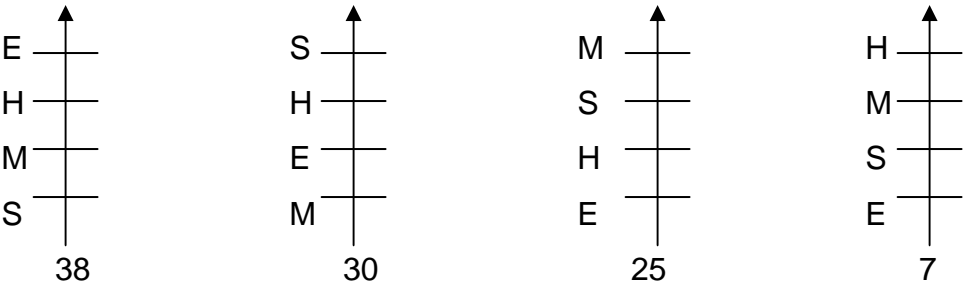
The Senior Dance Committee is deciding the format of this year's big event; the options are Caribbean Cruise, Hawaiian Holiday, or Riviera Romance. The nine Committee members rank them as follows: CHR, CHR, HRC, HRC, HRC, RCH, RCH, RCH, RCH.

Sequential Pairwise method:

Condorcet method:

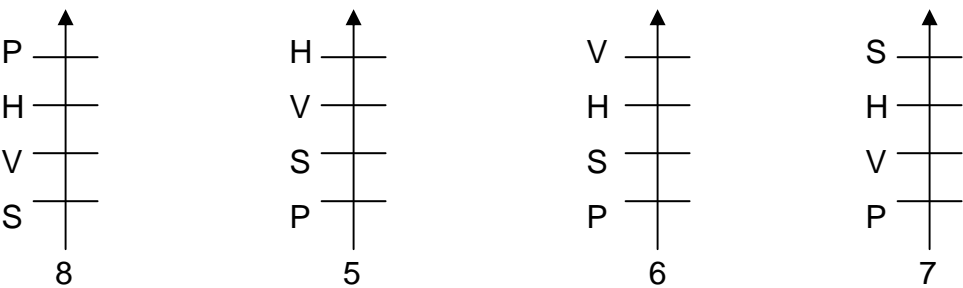
1.4 More Group Ranking Methods

Example 1



Approval method: Everyone approves of their first three choices.

Example 2



Approval method: Everyone approves of their first two choices.

### Example 3

The participants in a summer school recreation program decided to vote on which activity they preferred. The following summarizes the responses of the participants:

12 participants voted for Swimming and Badminton.

5 participants voted for Badminton, Running Track, and Softball.

10 participants voted for Running Track and Badminton.

13 participants voted for Softball and Badminton.

Which activity is selected by the summer school participants using Approval Voting?

### Example 4

Frisbee is a growing sport at Tama High. The Frisbee Club is sponsoring a weekend event, and each participant will receive a T-shirt. Here is a summary of the results:

12 participants voted for Steel Gray.

7 participants voted for Steel Gray and Sunflower Yellow.

20 participants voted for Eggshell and Candy Apple Red.

18 participants voted for Robin's Egg Blue, Eggshell, and Candy Apple Red

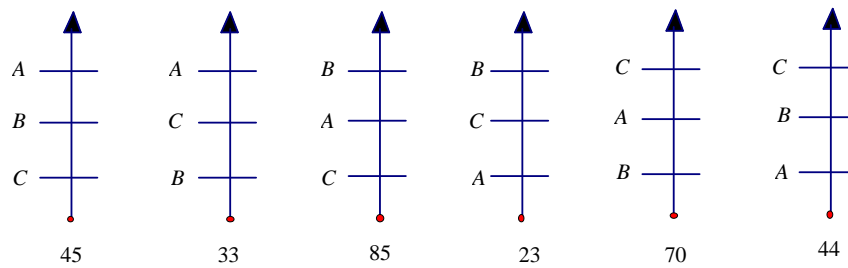
23 participants voted for Sunflower Yellow and Robin's Egg Blue.

25 participants voted for Candy Apple Red.

Use Approval Voting to determine the color of the tee-shirt.

## Voting Methods Review #1

Given the following voter preferences among three candidates, show that each of the candidates could emerge as the winner of the election, depending on what method is used to evaluate the results.



Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

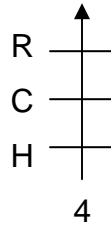
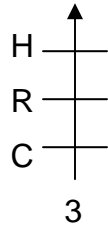
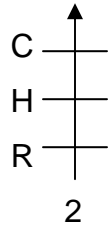
Sequential Pairwise method:

Condorcet method:

Use approval voting if each voter approves only his/her first and second choices?



Example 2



Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Use approval voting if each voter approves only his/her first and second choices?

## Voting Methods Review #2

Milbourn State University marching band has been invited to march in 5 different parades: the Rose Bowl parade, the Hula Bowl parade, the Cotton Bowl parade, the Orange Bowl parade and the Sugar Bowl parade. The band members were asked to rank the parades from 1st choice to 5th choice. Then results were summarized in the following preference schedule.

	39	16	45
1 <sup>st</sup>	Rose	Hula	Cotton
2 <sup>nd</sup>	Hula	Sugar	Hula
3 <sup>rd</sup>	Cotton	Orange	Sugar
4 <sup>th</sup>	Orange	Cotton	Orange
5 <sup>th</sup>	Sugar	Rose	Rose

The University now has to decide what to do with this information.

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Suppose the University decides to try Approval Voting. Which parade is chosen if, after re-polling, each band member approves only his/her first, second, and third choices?

Suppose the University decides to try Approval Voting. Which parade is chosen if, after re-polling, each band member whose first choice was the Cotton Bowl approved only of the Cotton Bowl, but everyone else approved of his/her first three choices?

Voting Methods Review #3

The student body at Geeky High School is having an election for homecoming queen. The results are shown below:

	3	4	9	9	2	5	8	3	12
Alice	1 <sup>st</sup>	1 <sup>st</sup>	1 <sup>st</sup>	4 <sup>th</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
Betty	2 <sup>nd</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>	1 <sup>st</sup>	1 <sup>st</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	4 <sup>th</sup>
Chloe	3 <sup>rd</sup>	4 <sup>th</sup>	2 <sup>nd</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	2 <sup>nd</sup>	1 <sup>st</sup>	1 <sup>st</sup>	2 <sup>nd</sup>
Dana	4 <sup>th</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	4 <sup>th</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	1 <sup>st</sup>

Show the results in a preference schedule.

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Suppose the school decides to use Approval Voting. Which girl is chosen if, after re-polling, each student approves only his/her first, second, and third choices?

Using Approval Voting, Which girl is chosen if, after re-polling, each student whose first choice was Dana only approved of Dana, but everyone else approved of his/her first two choices?

## Voting Methods Review 4

An election was held to try to determine the senior class President at Woodward. Students showed up to vote to elect one of five candidates Branden, Chelsea, Devin, Evan, or Gala (B, C, D, E, or G). Each voter was asked to list the candidates in the order of their preference. When the ballots were tabulated, we discovered that only 6 different preference schedules resulted as listed below.

Number of voters:	18	12	10	9	4	2
First Choice	G	B	C	D	E	E
Second choice	D	E	B	C	B	C
Third choice	E	D	E	E	D	D
Fourth Choice	C	C	D	B	C	B
Fifth Choice	B	G	G	G	G	G

- Explain what the 18 at the top of the second column means and the order G, D, E, C, B going down the column indicates. Be specific.
- How many total voters feel that the best candidate is B? is E?
- How many think the second best candidate is B? is C?
- How many total voters are there? What constitutes a majority in this election and did any candidate receive a majority?
- Determine the plurality winner. What was the winning percentage?
- Based on the votes in this election, why might the plurality winner **not** be considered the best candidate for the job of class president?
- In the above ballot, Who is eliminated in a runoff? According to the schedules above, who would the people who voted for C in the first round be likely to vote for?
- Determine the runoff winner. Who did he beat in the runoff and by what vote?

Number of voters:	18	12	10	9	4	2
First Choice	G	B	C	D	E	E
Second choice	D	E	B	C	B	C
Third choice	E	D	E	E	D	D
Fourth Choice	C	C	D	B	C	B
Fifth Choice	B	G	G	G	G	G

i) Who wins in a sequential runoff?

j) Determine the Borda count winner in this election. (You will need your calculator.)

k) Who wins using a Sequential Pairwise method?

l) Determine who is the Condorcet winner.

m) Suppose the school decides to use Approval Voting. Which person is chosen if, after re-polling, each student approves only his/her first, second, and third choices?

Number of voters:	18	12	10	9	4	2
First Choice	G	B	C	D	E	E
Second choice	D	E	B	C	B	C
Third choice	E	D	E	E	D	D
Fourth Choice	C	C	D	B	C	B
Fifth Choice	B	G	G	G	G	G

n) Suppose the nine people who prefer D decide that, since he is an unlikely winner, to switch the order of their votes to C – D – E – B – G. Will it change who wins by any of the methods that you have looked at thus far? What do we call this type of voting?



## Voting Methods Review #5

1. An election is being held to choose the president of the Math Anxiety Club. There are four candidates: Aaron, Boris, Carla, and Dawn (A, B, C, and D for short). Each of the 60 members of the club is asked to submit a ballot indicating his or her first, second, third, and fourth choices; ties are not allowed on individual ballots. The 60 ballots submitted are summarized in the following table.

First choice	B	D	C	A	A
Second choice	C	A	D	D	C
Third choice	A	C	A	C	D
Fourth choice	D	B	B	B	B
Number of voters	20	13	8	3	16

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first, second, and third choices?

2. Consider the following preference schedules for an election.

First choice	A	B	C	E	A
Second choice	D	C	D	D	E
Third choice	C	E	B	C	D
Fourth choice	E	D	E	B	B
Fifth choice	B	A	A	A	C
Number of voters	10	12	7	13	5

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first, second, and third choices?

3. An election was held in the Center City Garden Club to find a venue for their Spring Show. The choices are the Fincher Building, the Green Street Civic Center, the Hotel Morris, and the Inner Beltway Center. Preference schedules are:

F	↑	G	↑	H	↑	I	↑
I		H		F		G	
G		F		G		H	
H		I		I		F	
20		15		18		22	

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?

4. A new high school is planned in a large city, and a representative group of 25 students has been selected to vote on a mascot for the school. The choices and the preferences are seen in this table:

1 <sup>st</sup> choice:	<i>Wildcat</i>	<i>Bulldog</i>	<i>Bulldog</i>	<i>Pirate</i>
2 <sup>nd</sup> choice:	<i>Pirate</i>	<i>Pirate</i>	<i>Royal</i>	<i>Royal</i>
3 <sup>rd</sup> choice:	<i>Royal</i>	<i>Wildcat</i>	<i>Pirate</i>	<i>Wildcat</i>
4 <sup>th</sup> choice:	<i>Bulldog</i>	<i>Royal</i>	<i>Wildcat</i>	<i>Bulldog</i>
Number of votes:	7	8	5	5

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?

5. Eight voters are asked to rank 3 brands of automobiles: A, B, and C. The eight voters turn in the following ballots showing their preferences in order:

C B A A C B B A  
B C B B B C A B  
A A C C A A C C

Make a preference table for these ballots.

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?

## Voting Methods Review #6

1. Ten voters are asked to rank 4 brands of cell phones: A, B, C, and D. The ten voters turn in the following ballots showing their preferences in order:

```
A B B B A B B B A
B C A C B A C A A B
D A C A C C A D C C
C D D D D D D C D D
```

Make a preference table for these ballots.

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?

2. The Mathematics Department is holding an election for department chair. Each member ranks the candidates from first to third. The preference table below shows the results of the ballots with candidates Clark (C), Jones (J), and Smith (S).

Number of Votes	7	10	4	8
First	J	S	J	C
Second	S	J	C	S
Third	C	C	S	J

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?

3. Computer Specialists is planning a group vacation to one of the following locations: Alaska (A), Florida (F), San Antonio (S), or Hawaii (H). The employees rank the four possible sites according to the following preference table.

Number of Votes	5	7	4	7	5	6	8
First	A	H	F	A	A	H	F
Second	H	S	S	F	H	F	S
Third	F	A	H	S	S	S	A
Fourth	S	F	A	H	F	A	H

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?



4. A condominium association is holding an election for president of the board of directors. Each member ranks the candidates from first to third. The preference table below shows the results of the ballots with candidates Abbott(A), Blake (B), Cleary (C), and Downs (D).

	Number of Votes	3	7	5	8	7	4	6	6	4
First		A	B	A	A	C	B	D	C	C
Second		C	A	B	C	D	D	B	B	A
Third		B	C	C	D	A	A	A	D	D
Fourth		D	D	D	B	B	C	C	A	B

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?

5. Computer Specialists is planning a group vacation to one of the following locations: Alaska (A), Florida (F), San Antonio (S), or Hawaii (H). The employees rank the four possible sites according to the following preference table.

Number of Votes	5	7	4	7	5	6	8
First	A	H	F	A	A	H	F
Second	H	S	S	F	H	F	S
Third	F	A	H	S	S	S	A
Fourth	S	F	A	H	F	A	H

Plurality Winner:

Majority Winner:

Borda Count method:

Runoff method:

Sequential Runoff method:

Sequential Pairwise method:

Condorcet method:

Which is chosen if each voter approves only his/her first and second choices?